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ScienceDirect

Advances in Space Research xxx (2017) xxx–xxx

ADVANCES IN SPACE RESEARCH (a COSPAR publication)

www.elsevier.com/locate/asr

The lower ionosphere response to its disturbances by powerful radio waves

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Received 4 April 2017; received in revised form 6 July 2017; accepted 13 July 2017

Abstract

The paper presents data from some campaigns at Sura heating facility in 2011–1016. The experiments on probing of the artificial disturbed region of the lower ionosphere were carried out at two observation sites. One of them was located near Vasil'sursk 1 km from Sura facility (56.1°N; 46.1°E) and the other site was located at the Observatory (55.85°N; 48.8°E) of Kazan State University, 170 km to the East. Investigation of the features of the disturbed region of the lower ionosphere based on its diagnostics by the methods of the vertical sounding and oblique backscattering is the main goal of this paper. Ionosphere disturbance was fulfilled by the effect of the powerful radio wave of the ordinary or extraordinary polarization emitted by transmitters of the Sura facility with effective radiated power ERP = 50–120 MW at the frequency of 4.3, 4.7 and 5.6 MHz. Pumping waves were emitted with period from 30 s to 15 min. The disturbed region of the ionosphere in Vasil'sursk was probed by the vertical sounding technique using the partial reflexion radar at the frequency of 2.95 and 4.7 MHz. For the oblique sounding of the disturbed region the modified ionosonde Cyclon-M, operating at ten frequencies from 2.01 to 6.51 MHz was used at the Observatory site. On many heating sessions simultaneous variations of the probing partial reflection signals in Vasil'sursk and backscattered signals in Observatory were observed at the height at 40–100 km below the reflection height of the pumping wave. These observations were correlated with the pumping periods of the Sura facility. Possible mechanisms of the appearance of the disturbance in the lower ionosphere and its effect on the probing radio waves are discussed.

Keywords: Ionosphere modification; Lower ionosphere disturbances; Artificial irregularities; Ionospheric sounding; Oblique back scattering; Sura facility

1. Introduction

It is known that ionosphere modification using powerful radiowaves leads to generation of artificial irregularities of the plasma density with scales from centimeters to kilometers and more. The results of experimental and theoretical studies of artificial inhomogeneities are contained in a large number of publications (Allen et al.,1974; Minkoff et al., 1974; Belenov et al., 1977; Gurevich, 1978; Stubbe et al., 1982; Hedberg et al., 1983; Coster et al., 1985; Stubbe, 1996; Hysell et al., 1996, 2008; Bakhmetieva et al., 1997; Robinson et al., 1997; Bond et al., 1997; Franz et al., 1999; Rietveld et al., 2003; Blagoveshchenskaya et al., 2006; Kagan et al., 2006; Gurevich, 2007, 2012; Belikovich et al., 2007; Frolov et al., 2007; Crisham et al., 2008; Yeoman et al., 2008; and in many others).

For many years methods of vertical and oblique sounding of the ionosphere are applied to study the artificial disturbances in the ionosphere and to measure their

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http://dx.doi.org/10.1016/j.asr.2017.07.022
0273-1177/